Sugar Content of Fresh Apples and Pears in South Africa

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The individual sugar content, total solids, and total soluble solids of five apple and six pear cultivars harvested over three seasons in all of the main pome fruit production areas in South Africa were determined. Fructose was the main sugar component in all cultivars. The individual sugar composition did not differ significantly between apples and pears, except for sorbitol. Beurré Bosc and Winter Nelis pears, respectively, had much higher sucrose and glucose contents than other pear cultivars.

INTRODUCTION

Very few consumers are aware that the sugars present in fresh fruits are the main source of energy (Truswell, 1988). Fruits contain fructose, glucose, and sucrose in various combinations, but those containing high concentrations of free sugars should be restricted in the diet of diabetic patients (Nahar et al., 1990). The response of blood glucose to fructose is low in comparison with that to glucose, while the response to sucrose is intermediate between those of fructose and glucose (Miller et al., 1986). However, it was also found that oral fructose can be insulinogenic in humans when blood glucose levels are elevated (Reiser et al., 1987). Therefore, dieticians need more detailed information regarding the content of individual sugars in fruits to plan special diets for diabetics.

Little is known about the individual sugar content of South African pome fruit. The objectives of this study were to determine the sugar content of fruit of several South African apple and pear cultivars and to compare these results with those of the same cultivars reported from Australia.

EXPERIMENTAL PROCEDURES

Material. Fruit of Golden Delicious, Granny Smith, Starkrimson, Starking, and Topred apples and Beurré Bosc, Bon Chretien, and Packham's Triumph pears were harvested in seven different production areas. Due to availability, Beurré Hardy, Clapp's Favourite, and Winter Nelis pears were harvested in six production areas. Fruits were harvested during the 1984, 1985, and 1986 seasons at the optimum picking stage: apples from mid-February to mid-May and pears from early January to mid-March.

Method. Two random samples (20 kg) per area per season were analyzed. Contents of total solids, moisture, and total soluble solids (by refractometer) were determined on fresh fruit according to the AOAC methods (Williams, 1984). Individual and total sugars were determined gas chromatographically on freeze-dried samples as trimethylsilyl (TMS) derivates. A combination of OV-1 and OV-225 was used as stationary phase, and the programs employed, preparation of standards, and silylation were done according to the method of Fourie and Basson (1990). Sorbitol, a sugar alcohol, was also included in the analysis. Samples (1 g) were suspended in duplicate in distilled water (20 mL), heated to boiling point, cooled to room temperature, quantitatively diluted to 100 mL with ethanol, and filtered.

The results were subjected to analyses of variance using standard statistical techniques (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Apples (Table I). Fructose was the major sugar present in all cultivars. It comprised between 47.0% (Granny Smith) and 56.0% (Starking) of the total sugars, and the range varied from 3.8% (Granny Smith) to 5.5% (Starking). The glucose and sucrose content of Golden Delicious differed significantly from that of Starkrimson and Topred, while no significant differences were found between the other cultivars. Low values (0.3–0.4%) for sorbitol were recorded for all cultivars, with no significant differences between cultivars. Golden Delicious and Starking apples had similar individual sugar compositions.

The sugar content of Australian Golden Delicious and Granny Smith apples was reported by Wills and El-Ghetany (1986). Although cultivation practices and climatic conditions differ and genetic differences between South African and Australian grown cultivars may occur, fructose was also found to be the major sugar. Both cultivars contained higher fructose levels in Australian than in South African cultivars, but as in the present study Granny Smith had less fructose than Golden Delicious. In South African apples there was no significant difference in the glucose content between Golden Delicious and Granny Smith, while in Australia the glucose content of Golden Delicious was lower than that of Granny Smith. Sorbitol followed the same trend in both countries.

The contribution of total sugars to total soluble solids (°Brix) varied between 58.0% (Starkrimson) and 72.0% (Golden Delicious). Total soluble solid content at optimum picking stage varied from season to season, and this could have caused the variations in these contributions. The higher values for total soluble solids were probably due to substances with the same refractive index as sucrose. The total solid content of Granny Smith was significantly lower than that of the other cultivars. This difference was a result of the high moisture content of Granny Smith. Granny Smith apples are harvested only late in April, and early rains can influence the moisture level.

Pears (Table II). No significant differences in fructose content were found between cultivars. Fructose was the major sugar present and comprised 41.0% (Beurré Bosc) and 61.0% (Clapp's Favourite) of the total sugars. The glucose content of Winter Nelis was significantly higher than that of any other cultivar. The sorbitol content varied between 1.4% (Clapp's Favourite) and 2.7% (Beurré Bosc). Beurré Bosc had a significantly higher sucrose content than the other cultivars. This represented 25.0% of the total sugars, while the values for the other cultivars varied

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Table I. Individual Sugars and Related Components of Five Apple Cultivars (Means of 42 Samples per Cultivar)[a]

cultivar	sugar content, g/100 g					TS,[b] %	moisture, %	TSS,[c] °Brix
	fructose	glucose	sucrose	sorbitol	total			
Golden Delicious	5.18ab	2.00a	2.43a	0.43a	10.04a	16.69a	83.31b	13.88a
Granny Smith	3.81d	1.75ab	2.19ab	0.28a	8.04c	15.58b	84.42a	13.16a
Starkrimson	4.25cd	1.54b	1.84b	0.35a	7.98c	16.46a	83.54b	13.65a
Starking	5.48a	1.79ab	2.07ab	0.37a	9.71ab	16.94a	83.06b	13.66a
Topred	4.78bc	1.60b	1.93b	0.35a	8.66bc	16.70a	83.30b	13.66a
LSD ($P = 0.05$)	0.656	0.286	0.500	0.194	1.167	0.753	0.753	0.795

[a] Means in a column followed by the same letter do not differ significantly at $P = 0.05$. [b] Total solids. [c] Total soluble solids.

Table II. Individual Sugars and Related Components of Six Pear Cultivars[a]

cultivar	sugar content, g/100 g					TS,[b] %	moisture, %	TSS,[c] °Brix
	fructose	glucose	sucrose	sorbitol	total			
Beurré Bosc[d]	4.99a	1.36c	3.09a	2.65a	12.09a	18.93b	81.07c	16.15b
Beurré Hardy[e]	5.47a	1.69b	1.12c	1.65d	9.92bc	15.86cd	84.14ab	13.98cd
Bon Chretien[d]	5.36a	1.07d	0.96c	1.80cd	9.19bc	16.51c	83.49b	13.59de
Clapp's Favourite[e]	5.32a	1.00d	0.86cd	1.44d	8.62c	15.27d	84.73a	13.08e
Packham's Triumph[d]	5.69a	1.82b	0.53d	2.47ab	10.51b	16.46c	83.54b	14.76c
Winter Nelis[e]	5.34a	2.80a	1.73b	2.11bc	11.97a	20.49a	79.51d	17.63a
LSD ($P = 0.05$)	0.920	0.270	0.414	0.427	1.447	1.124	1.115	0.856

[a] Means in a column followed by the same letter do not differ significantly at $P = 0.05$. [b] Total solids. [c] Total soluble solids. [d] Means of 42 samples. [e] Means of 36 samples.

Table III. Comparison between Apple and Pear Cultivars of Individual Sugars and Related Components

cultivar	sugar content, g/100 g					TS,[a] %	moisture, %	TSS,[b] °Brix
	fructose	glucose	sucrose	sorbitol	total			
pears[c]	5.36	1.61	1.39	2.04	10.40	17.26	82.74	14.86
apples[d]	4.70	1.74	2.09	0.36	8.89	16.47	83.53	13.60
probability	0.1962	0.7274	0.1513	0.0004	0.0769	0.4371	0.4371	0.1462

[a] Total solids. [b] Total soluble solids. [c] Means of six cultivars. [d] Means of five cultivars.

between 5.0% and 14.0%. In the Australian study the sucrose level was 2.4% in Beurré Bosc and 0.3% in Packham's Triumph (Wills and El-Ghetany, 1986). In South Africa, Beurré Bosc contained 6 times more sucrose than Packham's Triumph.

Total sugars contributed between 66.0% (Clapp's Favourite) and 75.0% (Beurré Bosc) to total soluble solids. The variation was small as pears were cold stored and ripened to the same maturity stage. The high total solids value of Winter Nelis was due to the low moisture level of this cultivar, which in turn is influenced by the climatic conditions and harvesting time in a specific area.

Comparison between Apples and Pears (Table III). Pears were a better source of sorbitol than apples ($P < 0.01$). In pears the high sucrose value of Beurré Bosc increased the average sucrose value, but apples remained the better source. Although there were large differences between individual cultivars in the contribution of total sugars to total soluble solids, these differences were not reflected in the mean values obtained for pears (70.0%) and apples (68.4%).

These values for individual sugar composition of different apple and pear cultivars provide dieticians with the detailed information they need to make the planning of special diets more successful.

LITERATURE CITED

Fourie, P. C.; Basson, D. S. Sugar content of almond, pecan and macadamia nuts. *J. Agric. Food Chem.* **1990**, *38*, 101.

Miller, J. J.; Colagiuri, S.; Brand, J. C. The diabetic diet: Information and implications for the food industry. *Food Technol. Aust.* **1986**, *38* (4), 155.

Nahar, N.; Rahman, S.; Mosihuzzaman, M. Analysis of carbohydrates in seven edible fruits of Bangladesh. *J. Sci. Food Agric.* **1990**, *51*, 185.

Reiser, S.; Powell, A. S.; Yang, C.; Canary, J. J. An insulinogenic effect of oral fructose in humans during postprandial hyperglycemia. *Am. J. Clin. Nutr.* **1987**, *45*, 580.

Snedecor, G. W.; Cochran, W. G. *Statistical methods*, 7th ed.; The Iowa State University Press: Ames, IA, 1980; Chapter 11.

Truswell, A. S. The other carbohydrates—sugars. *Food Technol. Aust.* **1988**, *40* (7), 268.

Williams, S., Ed. *Methods of analysis*, 14th ed.; Association of Official Analytical Chemists: Arlington, VA, 1984.

Wills, R. B. H.; El-Ghetany, Y. Composition of Australian foods. 30. Apples and pears. *Food Technol. Aust.* **1986**, *38* (2), 77.

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Registry No. Fructose, 57-48-7; glucose, 50-99-7; sucrose, 57-50-1; sorbitol, 50-70-4.